

Unit 3: Chemical Calculations.

Calculating Molecular Mass

Apr 20, 2011

If you examine a Periodic Table you will find a value for the average atomic mass of an atom for each element.

i.e F has an average atomic of 19.00,

O has an average atomic mass of 16.00,

and Cl has an average atomic mass of 35.45

For an element like chlorine there are actually two types of atom, one with a mass of 35 and one with a mass of 37.

Atoms of the same element that have different masses are called isotopes. The atomic mass on a periodic table is the average mass of the different isotopes of an element.

Because atoms are so tiny their mass is not measured in grams, but in atomic mass units which use the symbol u .

So the mass of an iron atom is $55.85u$.

To determine a molecular mass we simply add up the atomic masses for each atom in the compound's formula.

Example #1 : Calculate the molecular mass of water, H_2O .

$$\begin{aligned} m_{\text{H}_2\text{O}} &= 2 \times m_{\text{H}} + m_{\text{O}} = 2(1.01 \text{ u}) + 16.00 \text{ u} \\ &= 18.02 \text{ u} \end{aligned}$$

\therefore the molecular mass of water is 18.02 u .

Example #2: Calculate the molecular mass
for copper (II) nitrate, $\text{Cu}(\text{NO}_3)_2$

$$\begin{aligned} m_{\text{Cu}(\text{NO}_3)_2} &= m_{\text{Cu}} + 2 \times m_{\text{N}} + 6 \times m_{\text{O}} = 63.55 \text{ u} + 2(14.01 \text{ u}) \\ &\quad + 6(16.00 \text{ u}) \\ &= 187.57 \text{ u}. \end{aligned}$$

\therefore the molecular mass of $\text{Cu}(\text{NO}_3)_2$ is
187.57 u.

The Mole Concept.

Although we can calculate the mass, of a single molecule, we usually use many many atoms or molecules in a chemical reaction.

A mole is a very large number of things, 602,000,000,000,000,000.000,000 of them. We use the concept of a mole the same way we use "dozen" to represent 12 of something.

The reason we use this large number is because one mole of a compound has the same mass in grams as one molecule does in u.

So if 1 molecule of water masses 18.02u then 1 mole of water masses 18.02g .

The molar mass of a compound is the mass of one mole of a substance. We represent molar mass with M and use units of g/mol .

Example #1 : Calculate the molar mass of NaCl.

$$M_{\text{NaCl}} = M_{\text{Na}} + M_{\text{Cl}} = 22.99 \text{ g/mol} + 35.45 \text{ g/mol} \\ = 58.44 \text{ g/mol.}$$

Example #2 : Calculate the molar mass of a compound if 2.4 moles of it has a 7.8 g.

$$M = \frac{7.8 \text{ g}}{2.4 \text{ mol}} = 3.25 \text{ g/mol}$$

\therefore the molar mass is 3.25 g/mol.